ECEARTH

- Background/Introduction
- Early experiments and sensitivity runs

KNMI: Frank Selten, Xueli Wang
Wilco Hazeleger, Rein Haarsma,
Henk van den Brink,Pier Siebesma,
Geert Lenderink, Peter van Velthoven,
Alwin Haklander, Camiel Severijns

with help of ECMWF

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Objective

Develop a global Earth System model consisting of a state-of-the-art atmospheric general circulation model, a state-of-the-art ocean general circulation model, a sea-ice model, a land model, and an atmospheric chemistry model.

At a later stage modules for the marine and terrestrial biogeochemical cycles

Considerations :

Follow “seamless prediction” strategy (medium range-seasonal-decadal-climate)

Take advantage of developments in ECMWF model: set up and diagnostics

Share common model architecture with several partners (European, national)

Share expertise and resources with ECMWF

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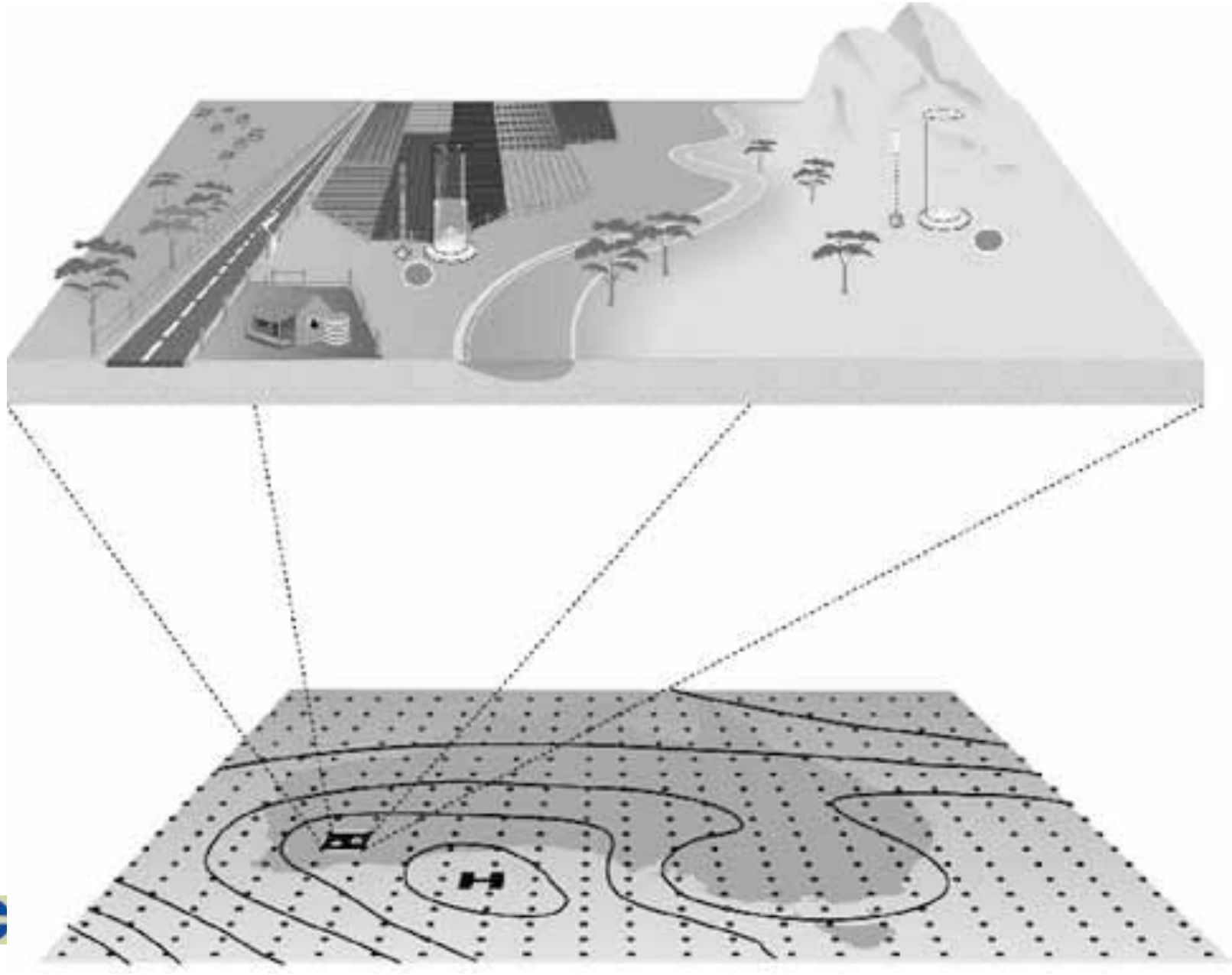
Motivation: Regional Applications



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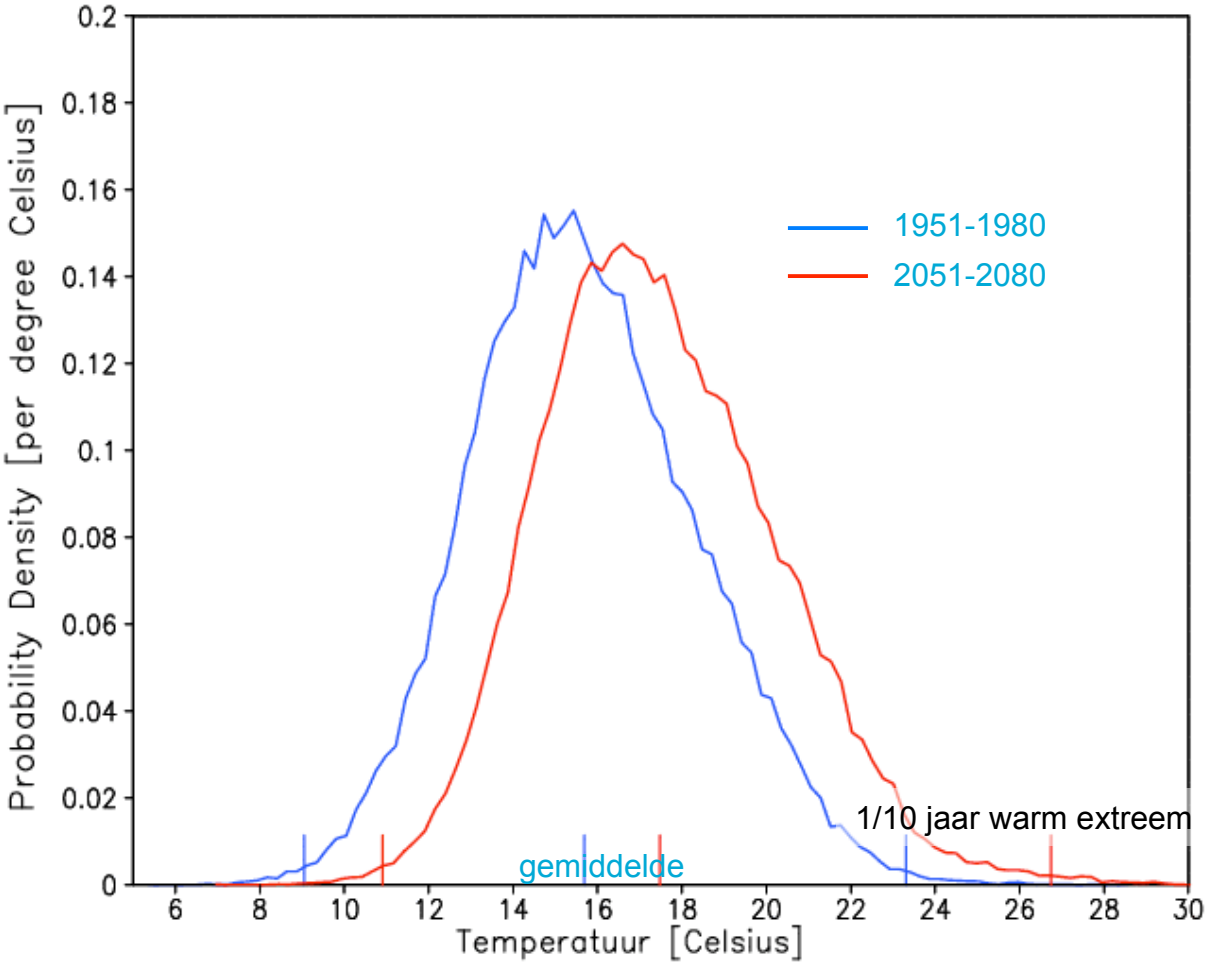
Motivation: Global projections

PDF temperature in August



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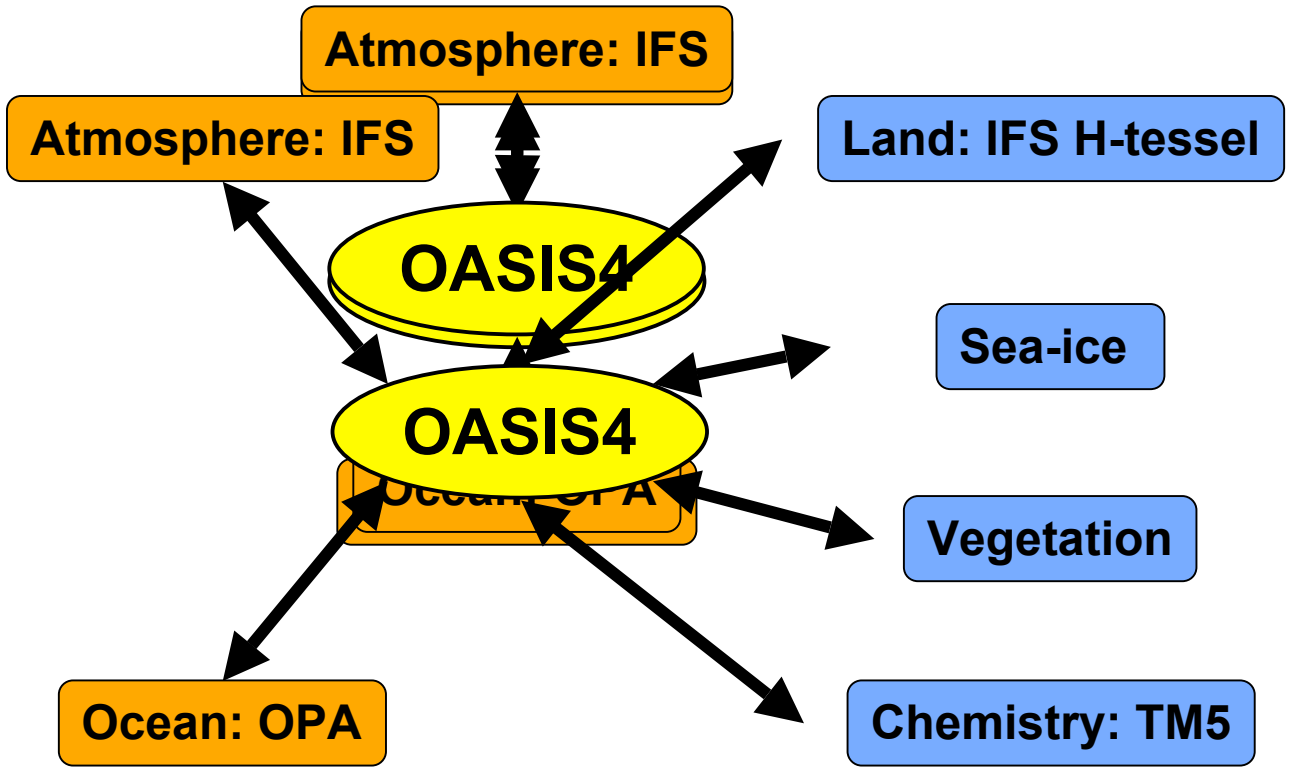
2007: System 4
Today: System 3
EC-EARTH



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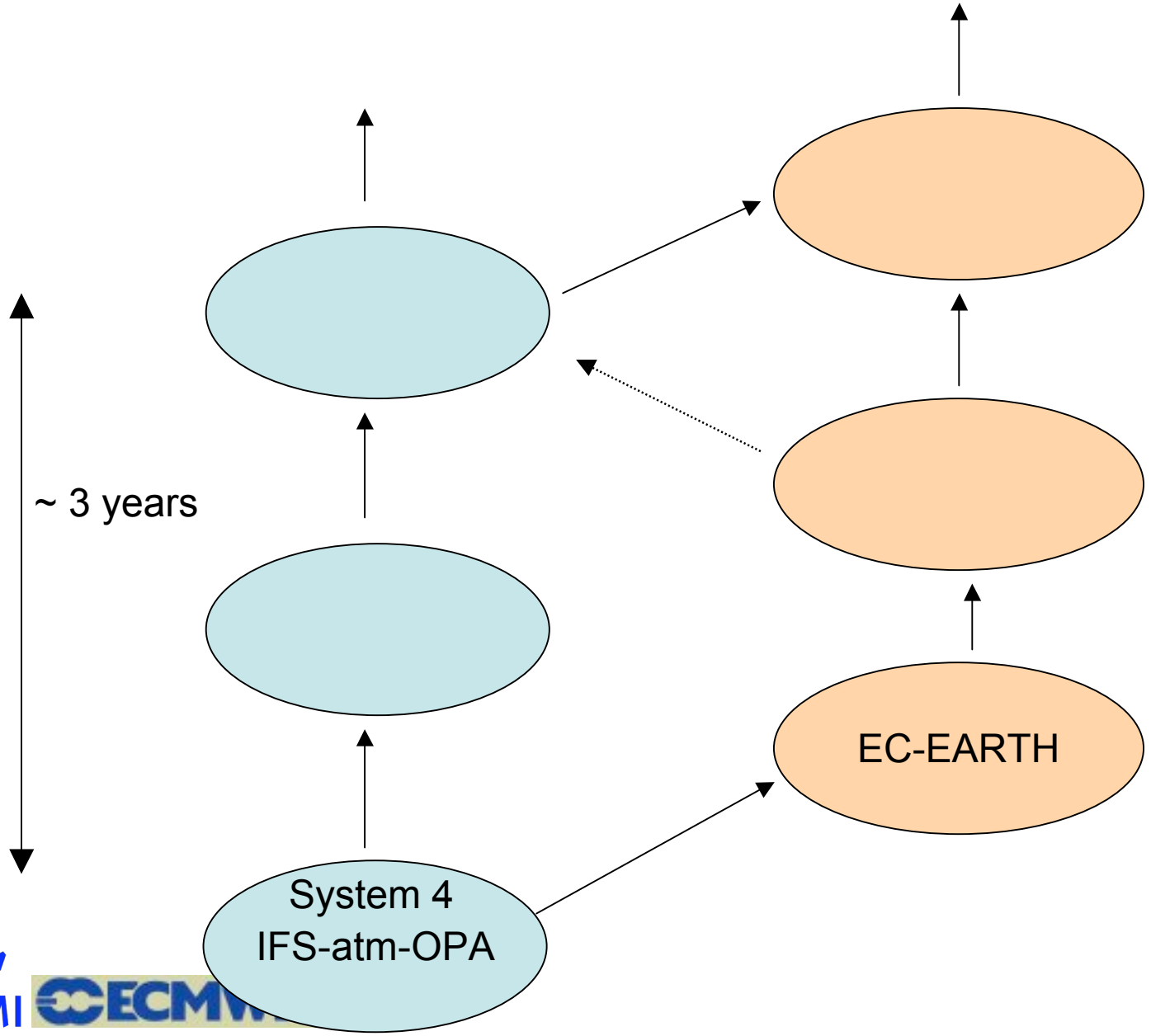
Development EC-EARTH

In phase with ECMWF cycles of the Seasonal Forecast System



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Early results: 10-year integrations

- Hindcasts with observed SSTs.
- Climatological SSTs
  - present climate
  - future climate (with future CO_2 concentr.)
- Sensitivity experiments:
  - Cloud parameterizations
  - Land model parameterizations

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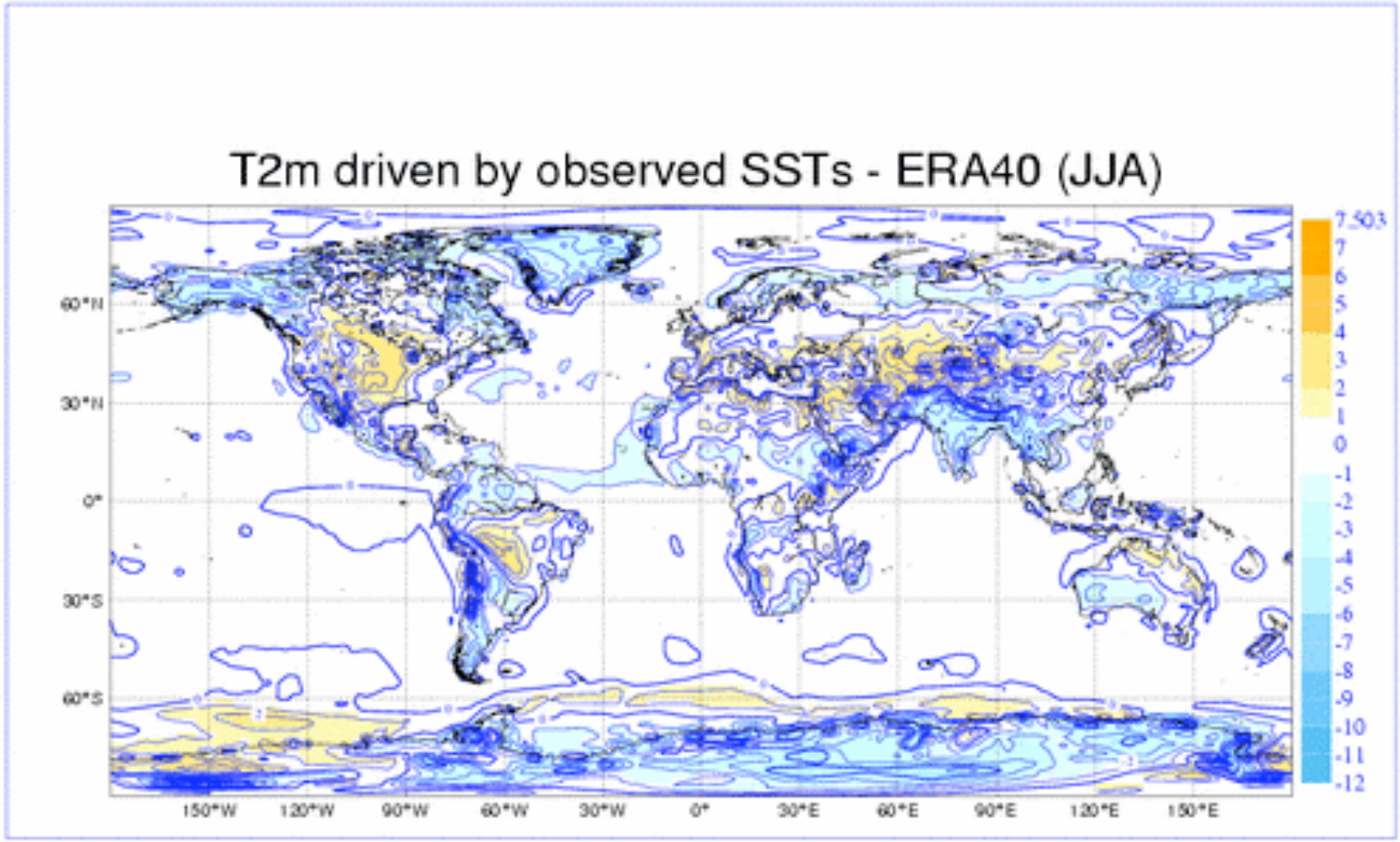
T2m driven by observed SSTs - ERA40 (JJA)
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
7.503
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12

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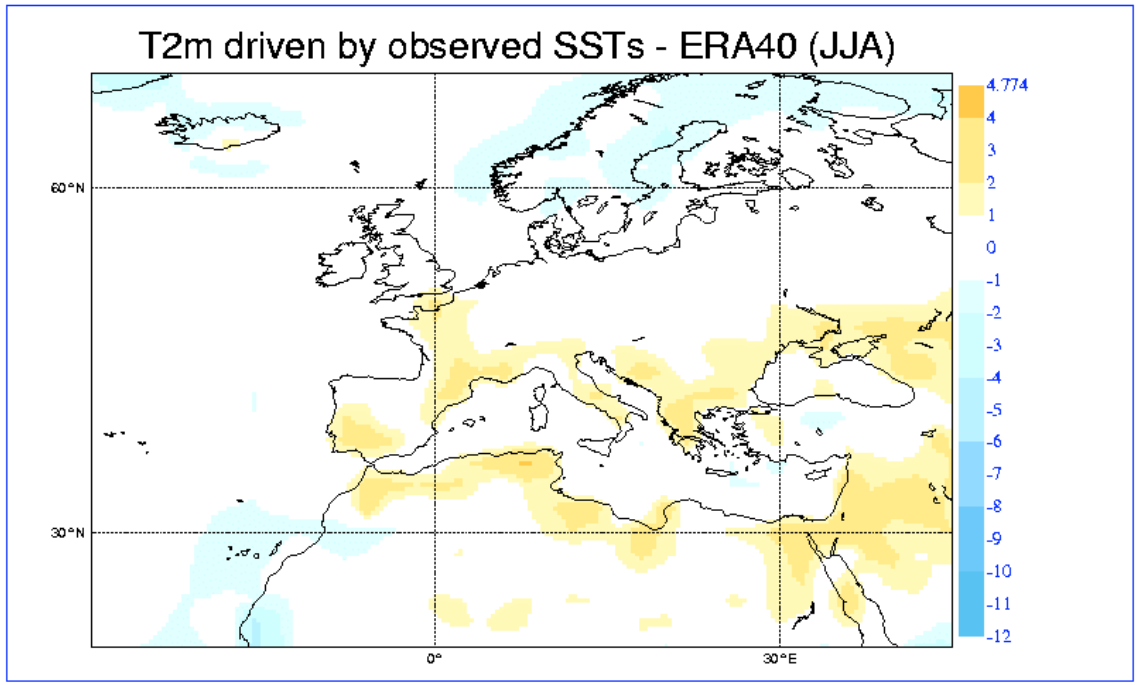

Too warm Mediterranean summer temperatures.

This is known from RACMO limited area model which is forced by ERA-40 boundaries and has the same physics as IFS model.

T2m temperatures in this area are sensitive to vegetation stress

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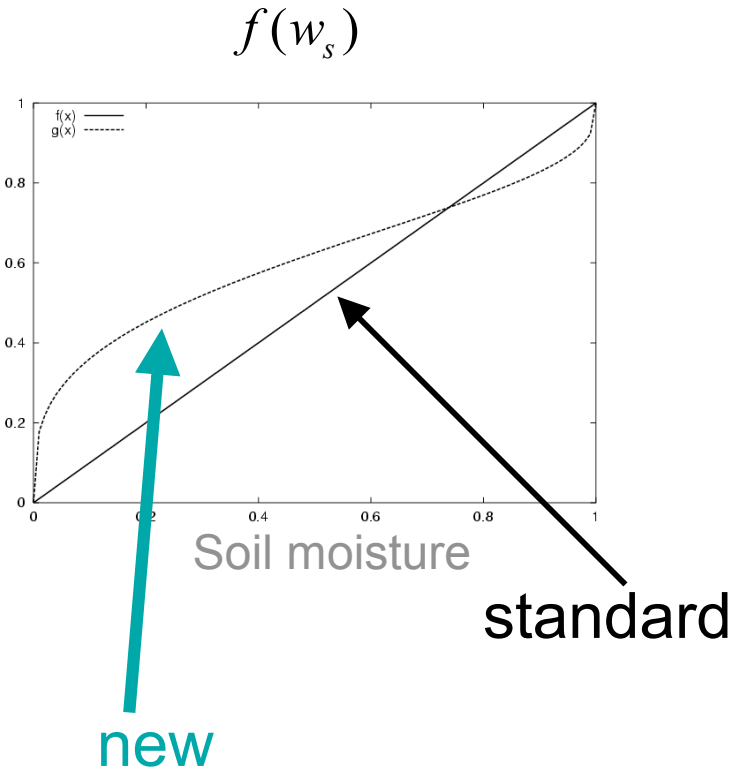
Soil physics
vegetation stress

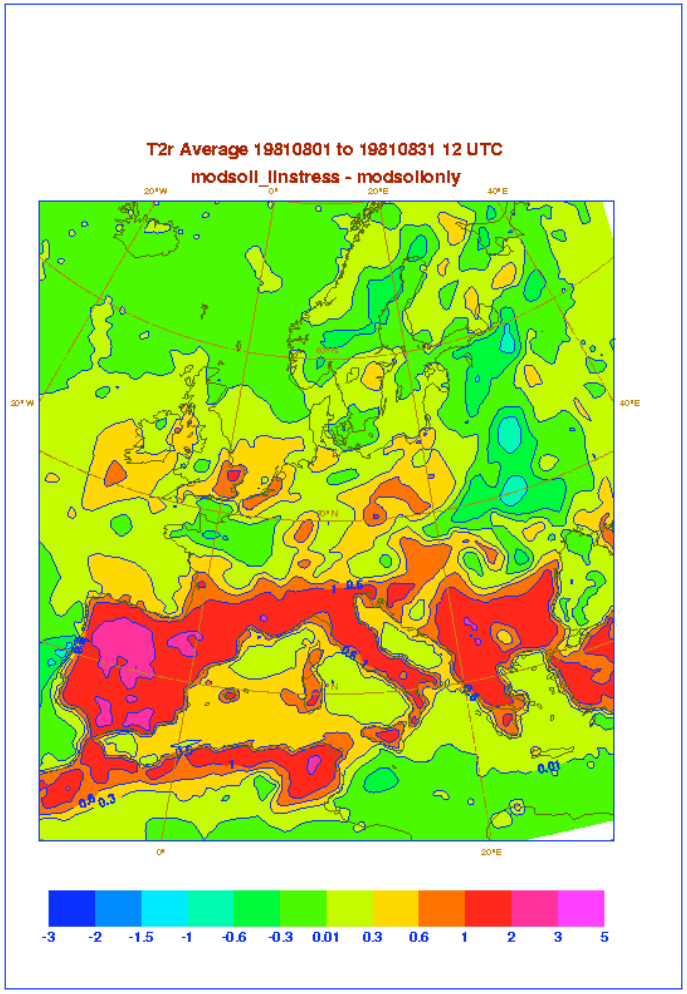
$$E = \frac{\rho_a}{r_a + r_c}\left(q_{sat}(T_{sk}) - q_l\right)$$

$$r_c^{-1} = f(w_s)G(R, LAI, \ldots),$$



Effect of vegetation stress function in RACMO

Standard – New



T2m 12 UTC August 1981

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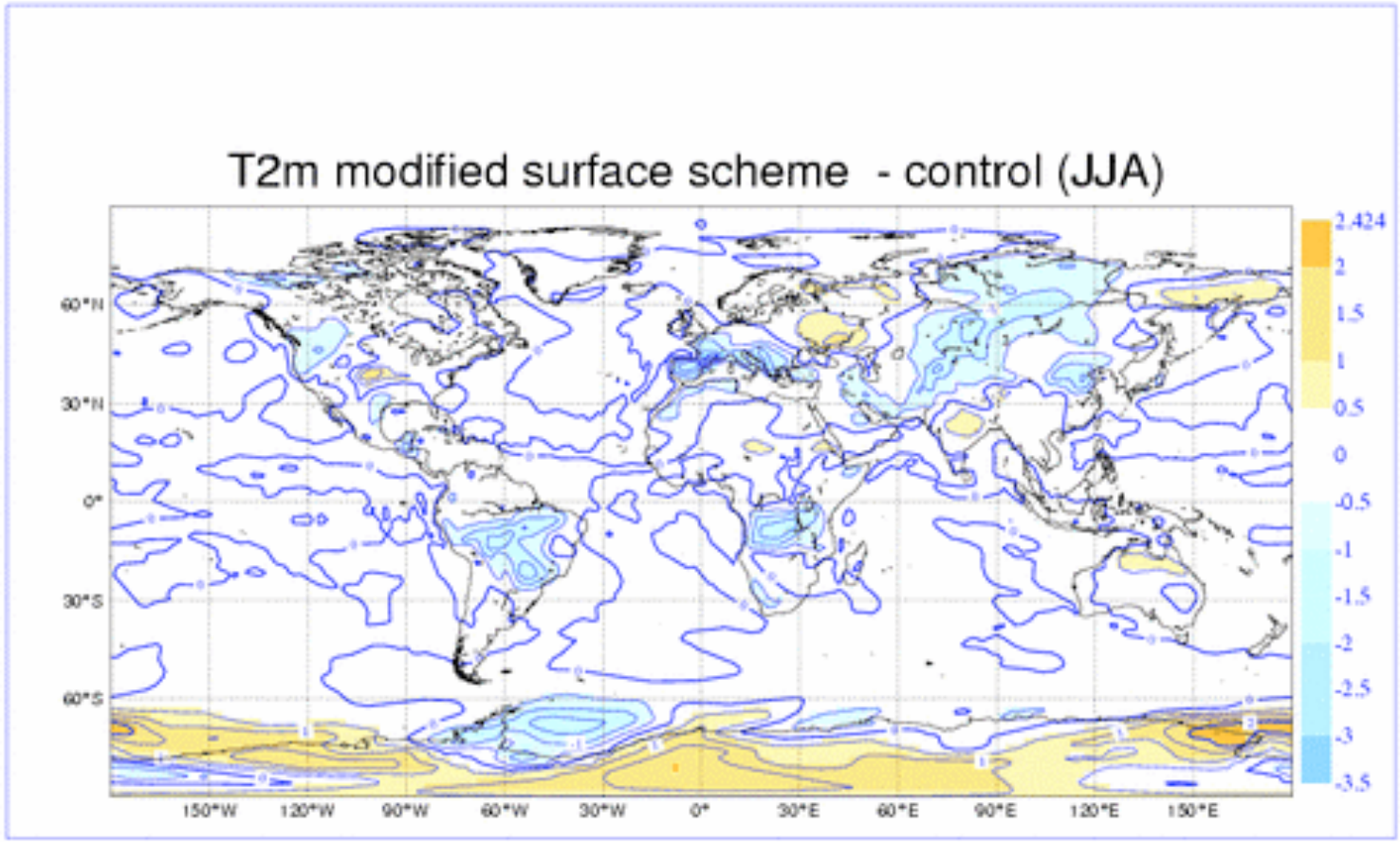
T2m modified surface scheme - control (JJA)
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
2.424
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5

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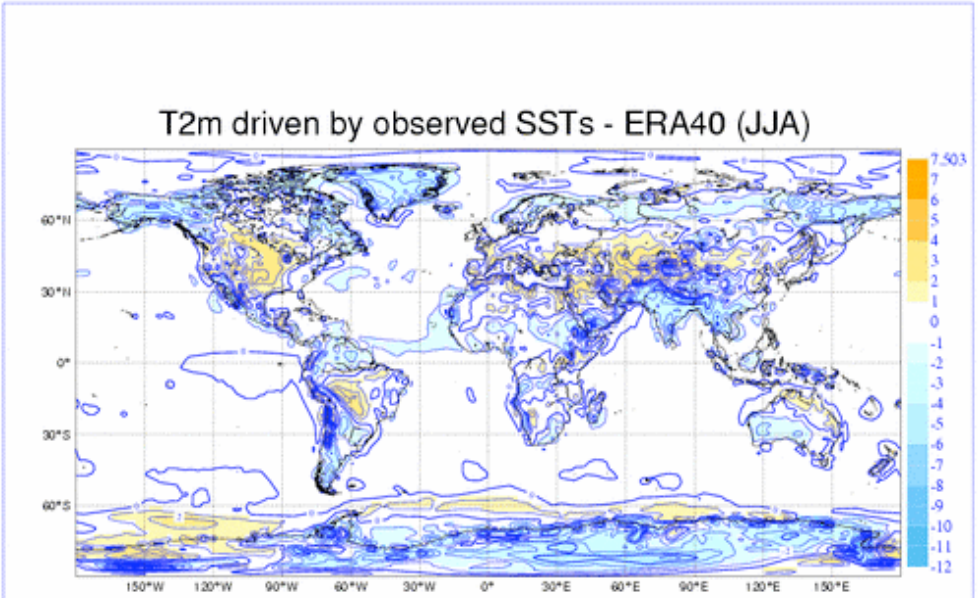
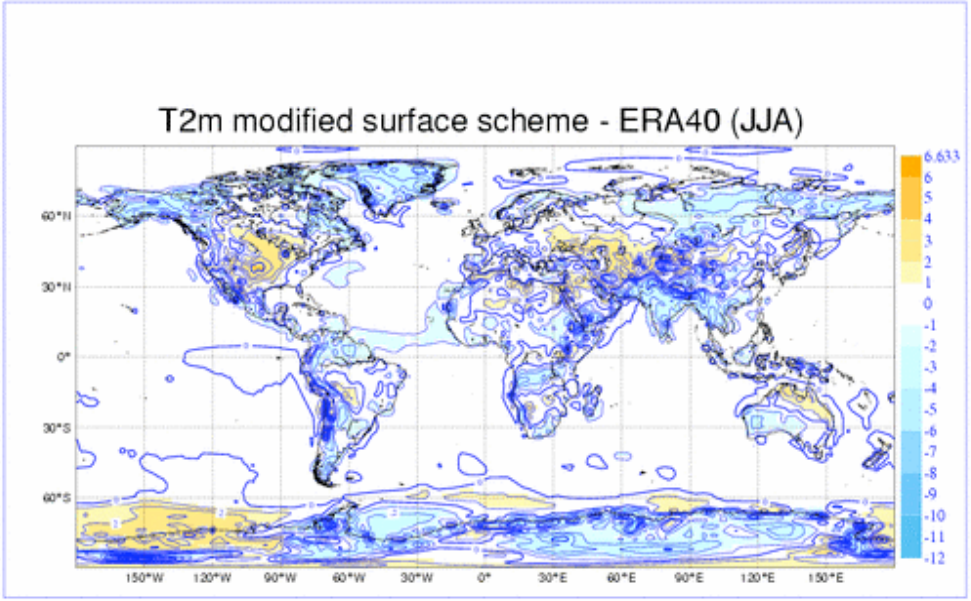

T2m driven by observed SSTs - ERA40 (JJA)
7.503
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E


T2m modified surface scheme - ERA40 (JJA)
6.633
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E

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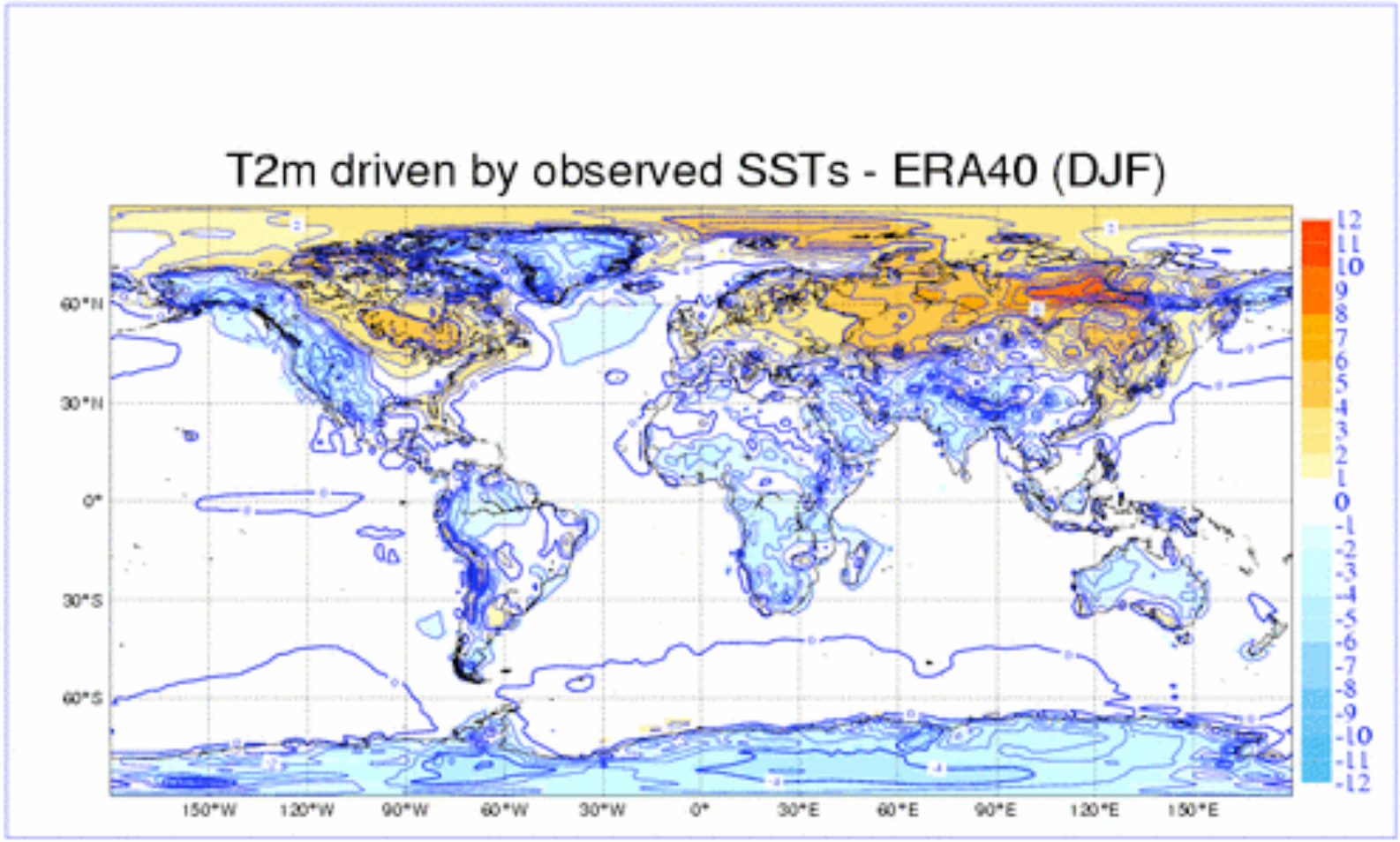
T2m driven by observed SSTs - ERA40 (DJF)
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12

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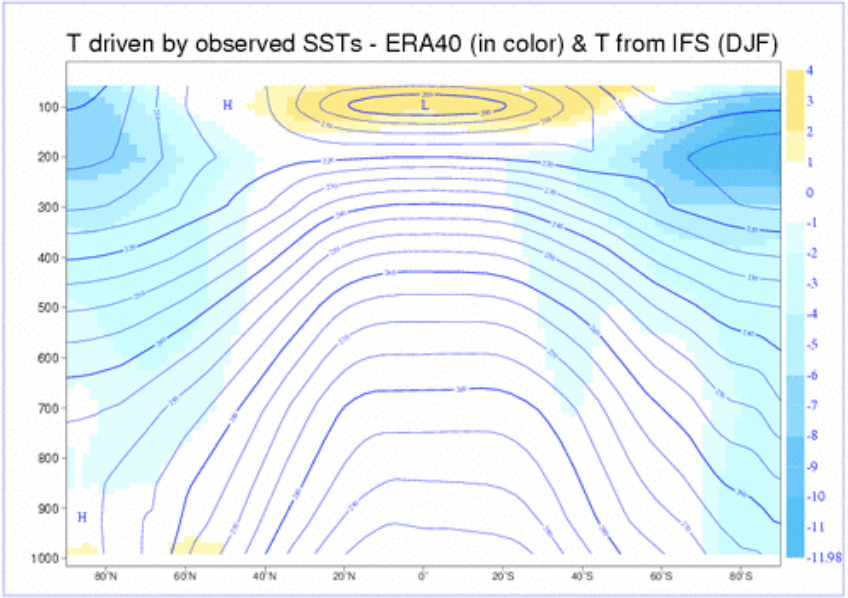
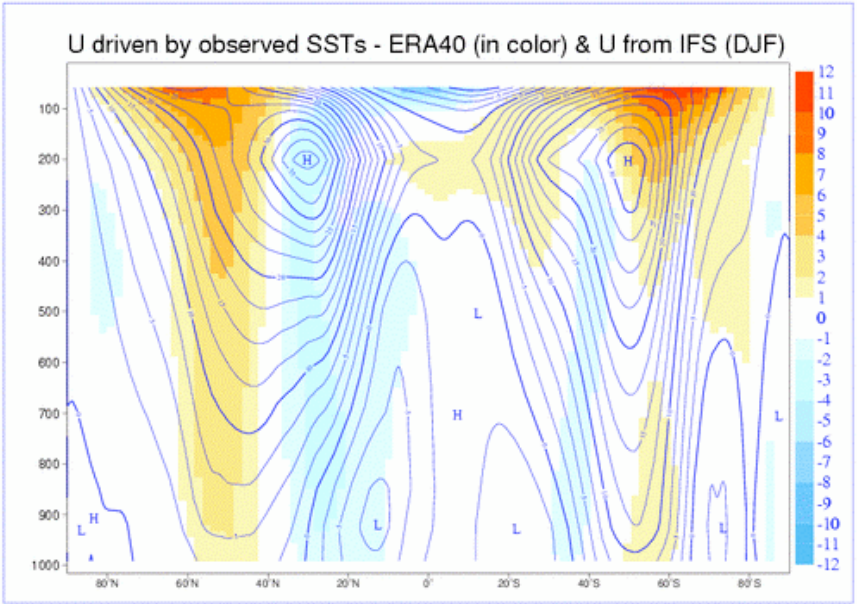

T driven by observed SSTs - ERA40 (in color) & T from IFS (DJF)
100
200
300
400
500
600
700
800
900
1000
80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-11.98


U driven by observed SSTs - ERA40 (in color) & U from IFS (DJF)
100
200
300
400
500
600
700
800
900
1000
80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12

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Sensitivity for cloud parameters

- No lateral entrainment of thermals in dry convective boundary layer
- Increased top entrainment for stratocumulus

CMIP project

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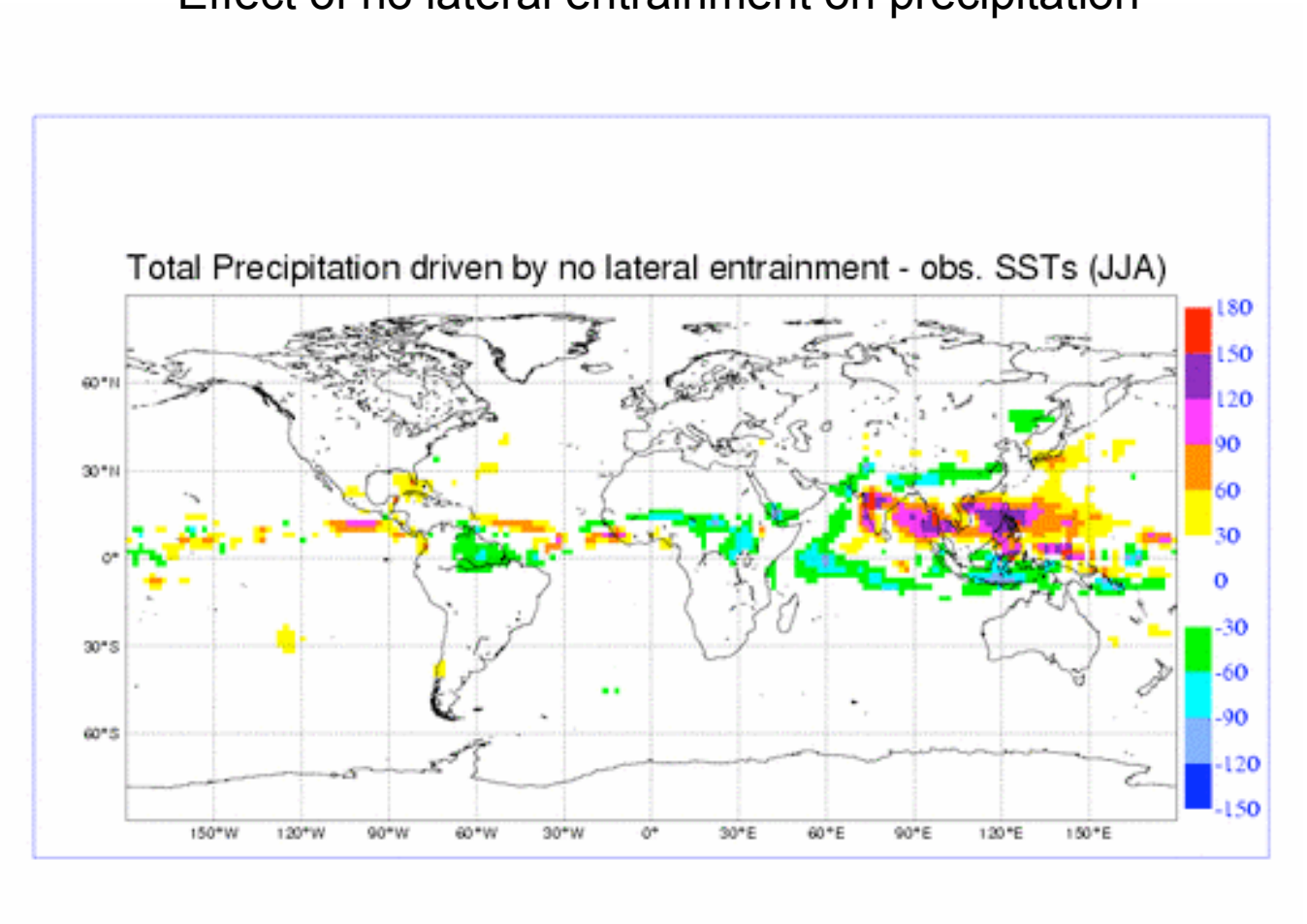
Effect of no lateral entrainment on precipitation



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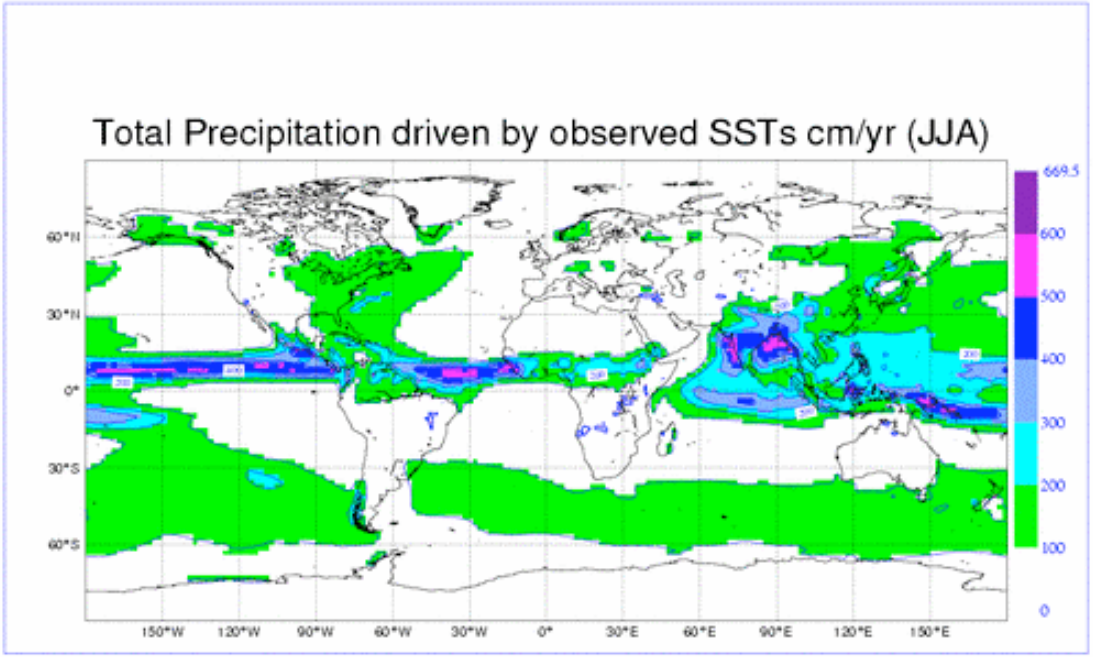
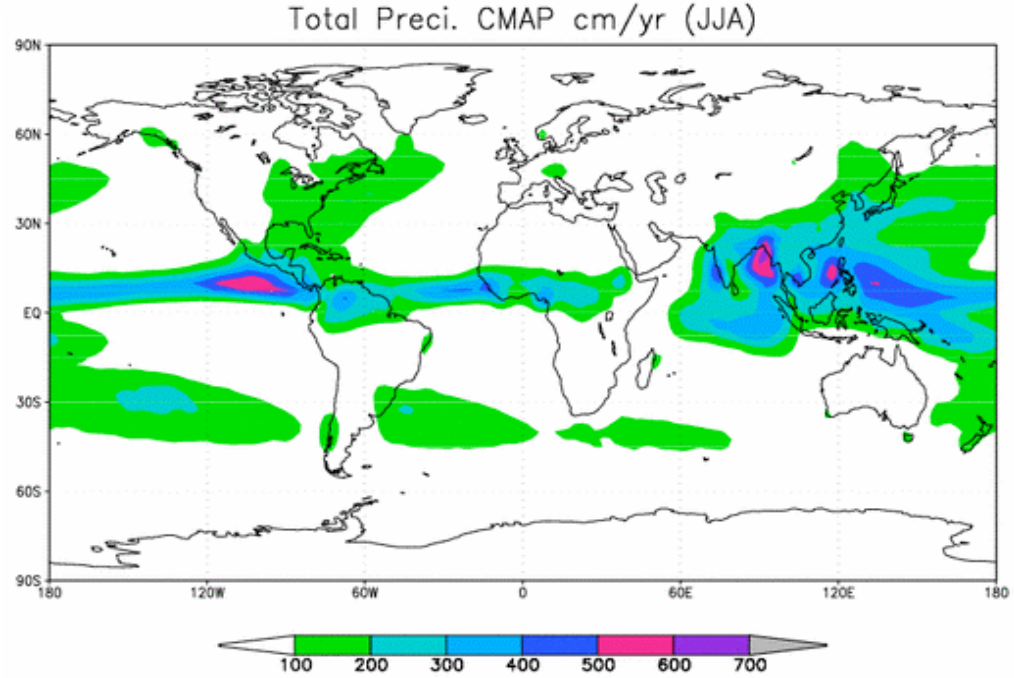

Total Precipitation driven by observed SSTs cm/yr (JJA)
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
669.5
600
500
400
300
200
100
0


Total Preci. CMAP cm/yr (JJA)
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
100
200
300
400
500
600
700

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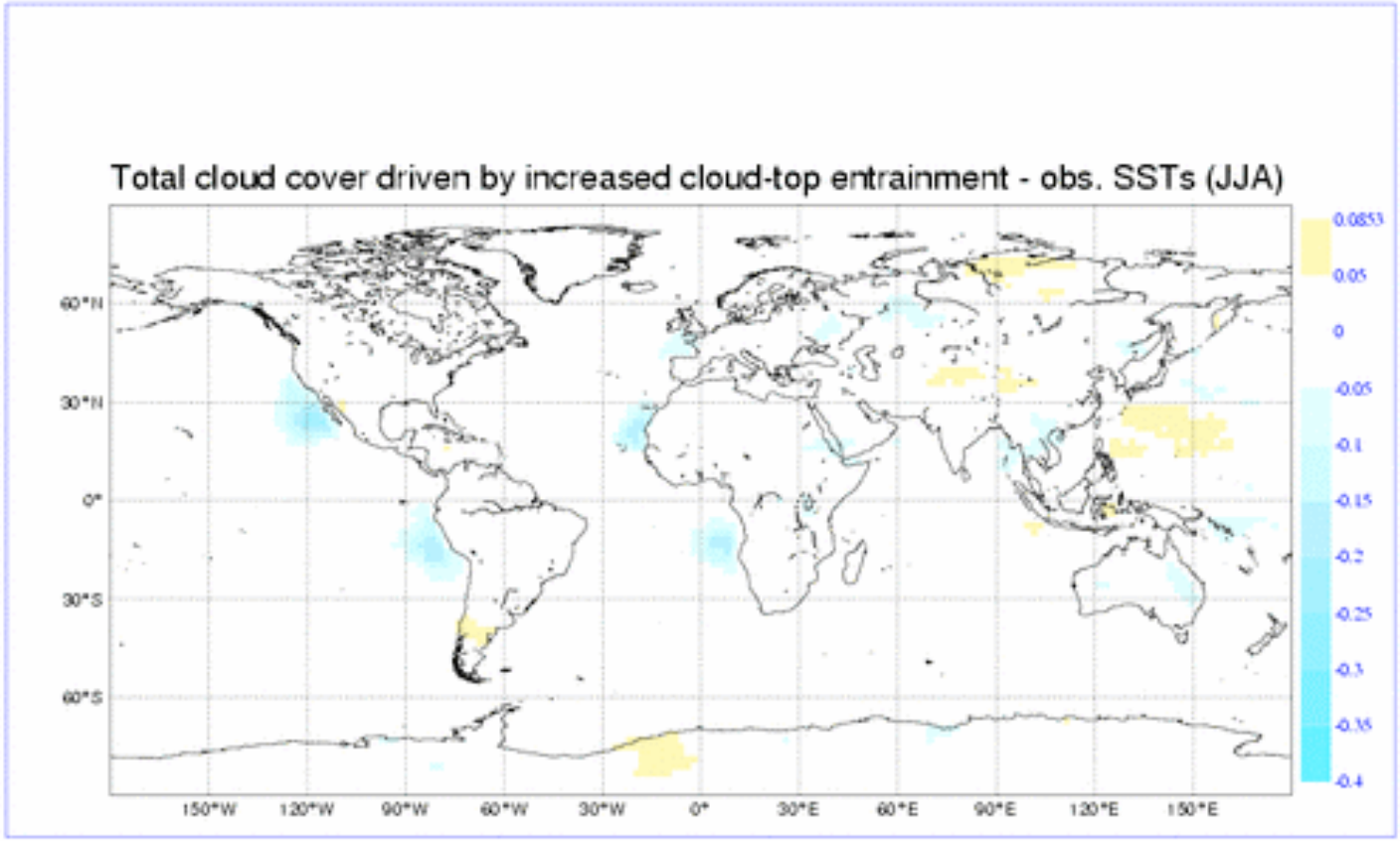
Total cloud cover driven by increased cloud-top entrainment - obs. SSTs (JJA)
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
0.0853
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4

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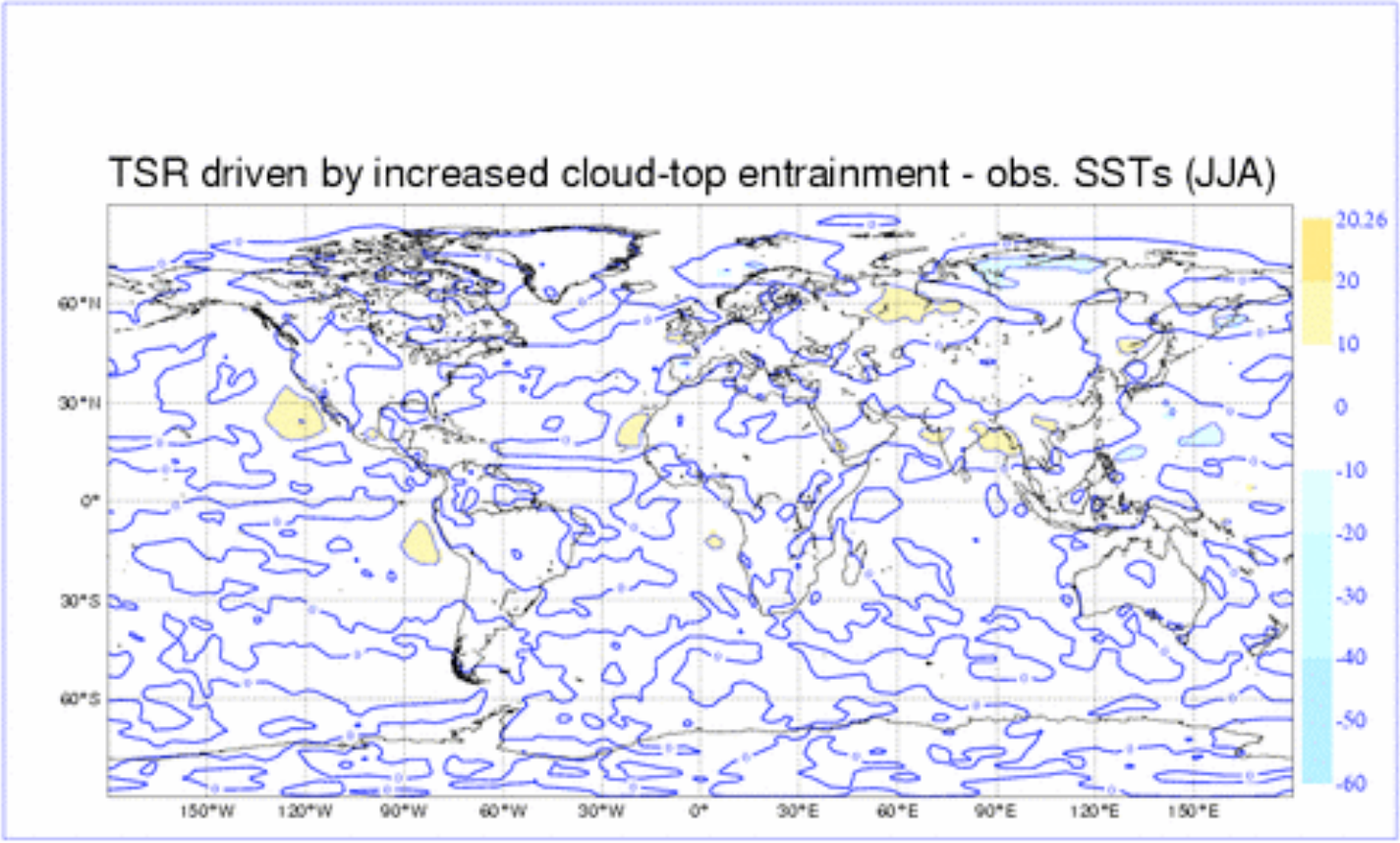
TSR driven by increased cloud-top entrainment - obs. SSTs (JJA)
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
20.26
20
10
0
-10
-20
-30
-40
-50
-60

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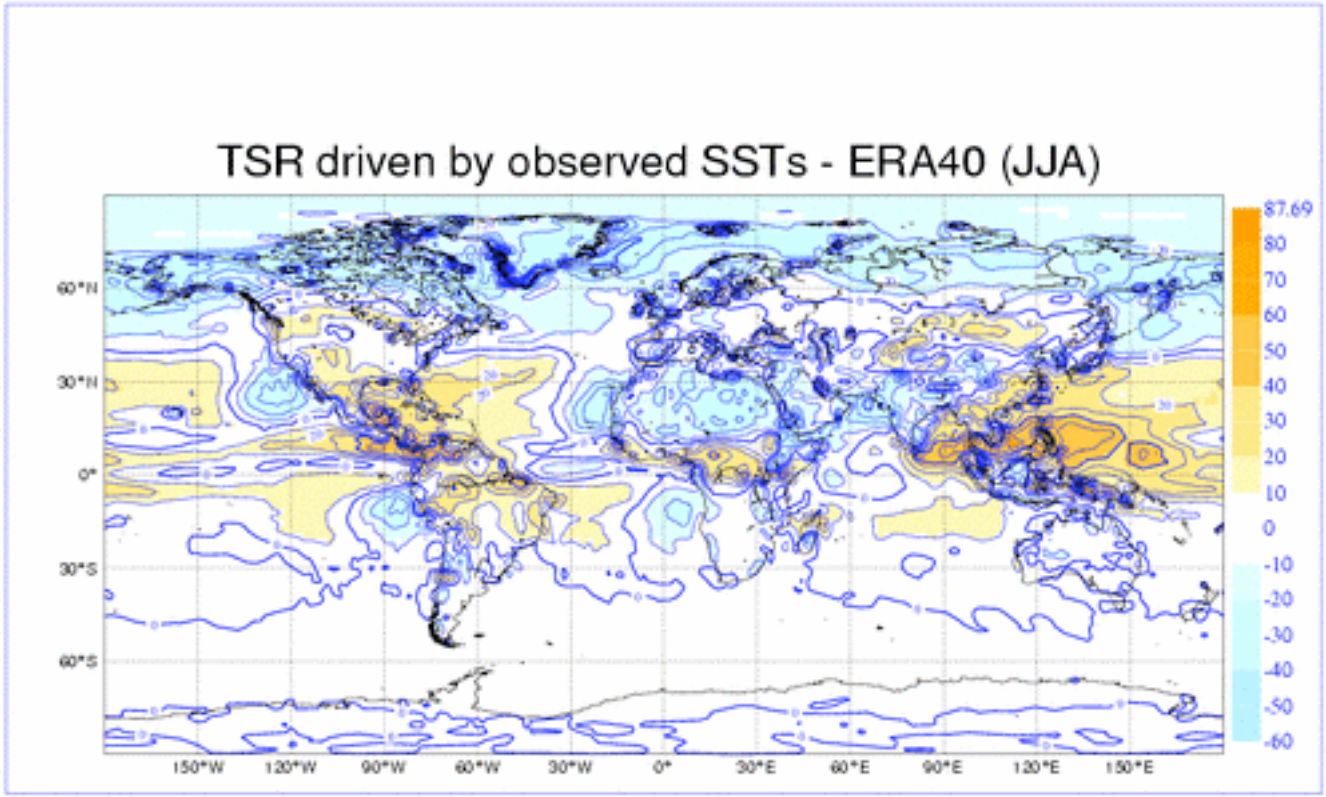
TSR driven by observed SSTs - ERA40 (JJA)
87.69
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
60°N
30°N
0°
30°S
60°S
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E

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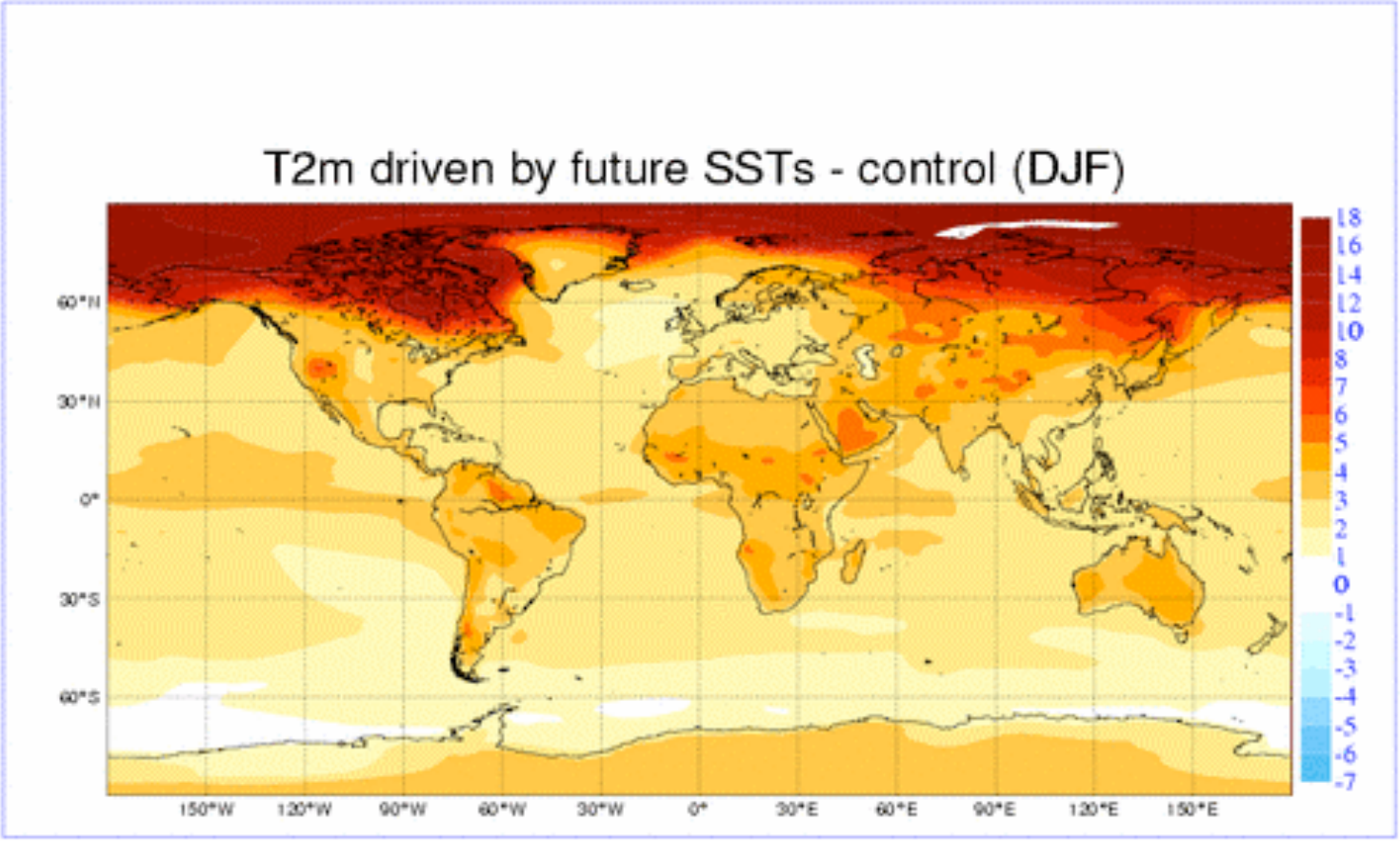
SSTs of future climate are computed from AR4 simulations (selected set). SRES-A1 scenario 2080-2089.

SSTs of control run are computed from ERA-40 data set



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Summary

Model still has significant statistical errors

Sensitivity runs to investigate origins of model errors. Results of RACMO are used to design these experiments.

First GHG experiments are performed

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